IS 10242-1-1 (1997): Electrical installations in ships, Part 1: General, Section 1: Definitions and general requirements [ETD 20: Electrical Installation]

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IS 10242 (Part 1/Sec 1) : 1997
(Reaffirmed 2002)

भारतीय मानक

जहाजों में विद्युत-संस्थापन — विशिष्टि

भाग 1 सामान्य

अनुभाग 1 परिभाषाएं और सामान्य अपेक्षाएं

(पहला पुनरीक्षण)

Indian Standard

ELECTRICAL INSTALLATIONS IN SHIPS — SPECIFICATION

PART 1 GENERAL

SECTION 1 DEFINITIONS AND GENERAL REQUIREMENTS

(First Revision)

ICS 47.020.60 ' 01.040.47

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July 1997

Price Group 5

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Electrical Equipment and Installations in Ships Sectional Committee had been approved by the Electrotechnical Division Council.

This revision has been undertaken to include the International convention on safety of life at sea (SOLAS) and its amendments as far as practicable.

This standard (Part 1/Sec 1) has been prepared to cover the requirements for electrical installations in sea-going ships, incorporating good practices and co-ordinating as far as possible existing rules. This standard, along with other parts, provides a code for practical interpretation and amplification of the requirements of guide for future regulations which may be prepared and a statement of practice for use by ship-owners, ship-builders and appropriate organizations.

This standard (Part 1/Sec 1) is one among the series of Indian Standards on electrial installation in ships. This series will have the following parts:

Part 1 General

Part 2 System design

Part 3 Equipment

Part 4 Installation and test of completed installation

Part 5 Special features

NOTES

1 Attention is drawn to the requirements of the International Convention for the safety of life at sea.

2 This section contains conditions and requirements which are common to all apparatus and installations.

In the preparation of this standard assistance has been taken from IEC Publication 92 - 101 General definitions and general requirements issued by the International Electrotechnical Commission.

This part of the standard shall be read in conjunction with the other parts mentioned above.

For the purpose of deciding whether a particular requirements of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ELECTRICAL INSTALLATIONS IN SHIPS — SPECIFICATION

PART 1 GENERAL

SECTION 1 DEFINITIONS AND GENERAL REQUIREMENTS

(First Revision)

1 SCOPE

1.1 This standard (Part 1/Sec 1) covers the definitions and general requirements for electrical installations in ships.

2 REFERENCES

2.1 The Indian Standards listed below are necessary adjuncts to this standard:

IS No.	*Title*
2259 : 1963	Methods of test for determination of insulating resistance of solid insulating materials
2824 : 1975	Method of determining the comparative tracking index of solid insulating materials under moist conditions
10242 (Part 5/Sec 4)	Electrical installations in ships : Part 5 Special features, Sec 4 Control and instrumentation

3 DEFINITIONS

3.0 General

3.0.1 The definitions included in this section are those having general application in these standards.

3.0.2 Definitions applying to particular apparatus or equipment are included in the other parts of this standard.

3.0.3 The following definitions indicate the sense in which the expressions defined are used in these standards.

3.1 Appropriate Authority

A governmental body and/or classification society with whose rules a ship is required to comply.

3.2 Ocean - Going Ship

Any ship not exclusively employed in the navigation of rivers or inland waters.

3.3 Essential Services

Services which are essential for the navigation, steering or manoeuvring of the ship or for the safety of human life or for special characteristics of the ship (for example, special services).

3.4 Accessible

3.4.1 *Accessible (as Applied to Equipment)*

Accessible means that an object or device can be inadvertently touched or approached nearer than a safe distance by any person. It is applied to objects not suitably guarded or insulated.

3.4.2 *Accessible (as Applied to Wiring Methods)*

Accessible means not connected.

3.5 Accessory

Any device, other than a luminaire, associated with the wiring and current-using appliance of an installation, for example, a switch, a fuse, a plug, a socket-outlet, a lampholders or a junction box.

3.6 Band

The connection of non-current-carrying parts to ensure continuity of electrical connection or to equalize the potential between parts comprising, for example, armour or lead sheath of adjacent length of cable, the bulkhead, etc, for example, bulkhead and cables in a radio-receiving room.

3.7 Earth Grounded

A conductor connected to the general mass of the hull of the ship in such a manner as will ensure at all times an immediate discharge of electrical energy without danger.

NOTE — A conductor is said to be 'solidly-earthed' when it is electrically connected to the hull without a fuse-link, switch, circuit-breaker, resistor, or impedance, in the earth connection.

3.8 Earth

3.8.1 *Earth (Ground)*

The general mass of the metal hull of the ship.

3.9 Basic Insulation

Insulation applied to live parts to provide basic protection against electric shock.

NOTE — Basic insulation does not necessarily include insulation used exclusively for functional purposes.

3.10 Supplementary Insulation

Independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation.

3.11 Double Insulation

Insulation comprising both basic insulation and supplementary insulation.

3.12 Reinforced Insulation

A single insulation system applied to live parts which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant Indian Standards.

NOTE — The term "insulation system" does not imply that the insulation shall be one homogeneous piece. It may comprise several lavers which cannot be tested singly as supplementary or basic insulation.

3.13 Live

A conductor or circuit is live when a difference of potential exists between it and earth.

3.14 Section Board

A Switchgear and controlgear assembly for controlling the supply of electrical power to other section boards distribution boards or final sub-circuits.

3.15 Distribution Board

An assembly of one or more overcurrent protective device, arranged for the distribution of electrical power to final sub-circuits.

3.16 Final Sub-Circuit

Portion of a wiring system extending beyond the final overcurrent protective device of a board.

3.17 Point (In Wiring)

Any termination of the fixed wiring intended for the attachment of a luminaire or for connecting the supply a current-using appliance.

3.18 Voltage

3.18.1 *Voltage Tolerance*

The maximum departure from nominal user voltage during normal operating conditions, excluding transient and cyclic voltage variations.

NOTE — Voltage tolerance is a steady state tolerance and includes voltage drop in cables and voltage regulator characteristics. It also includes variations due to environmental conditions.

3.18.2 *Voltage Unbalance Tolerance*

The difference between the highest and lowest phase to phase voltage.

3.18.3 *Voltage Cyclic Variation Deviation*

The periodic voltage deviation (maximum to minimum r.m.s. values) of the nominal voltage such as might be caused by regularly repeated loading.

$$\text{Voltage Cyclic Variation} = \pm \frac{(U_{Max} - U_{Min}) \times 100}{2\,U\,\text{Nominal}}$$

3.18.4 *Voltage Transient*

A sudden change in voltage (excluding spikes) which goes outside the nominal voltage tolerance limits and returns to and remains inside these limits within a specified recovery time after the initiation of the disturbance (time range seconds).

3.19 Waveform

3.19.1 *Total Harmonic Distortion*

The ratio of the r.m.s. value of the residue, after elimination of the fundamental, to the r.m.s. value of the fundamental expressed in percent.

3.19.2 *Single Harmonic*

The single harmonic content of a voltage wave is the ratio of the effective r.m.s. value of that harmonic to the r.m.s. value of that harmonic to the r.m.s. value of the fundamental expressed in percent.

3.20 Frequency

3.20.1 *Frequency Tolerance*

The maximum departure from nominal frequency during normal operation conditions excluding transient and cyclic frequency variations.

NOTE — Frequency tolerance is a steady state tolerance and includes variations caused by loads and governor characteristics it also includes variations due to environmental conditions.

3.20.2 *Frequency Cyclic Variation*

The periodic deviation in frequency during normal operation such as might be caused by regularly repeated loading.

$$\text{Frequency cyclic variation} = \pm \frac{(f_{Max} - f_{Min}) \times 100}{2f\,\text{Nominal}}$$

3.20.3 *Frequency Transient*

A sudden change in frequency which goes outside the frequency tolerance limits and returns to and remains inside these limits within a specified recovery time after initiation of the disturbance (time range seconds).

3.21 Time

3.21.1 *Voltage Transient Recovery Time*

The time elapsed from exceeding the normal tolerance until the voltage recovers and remains within the normal tolerance limits.

3.21.2 *Frequency Transient Recovery Time*

The time elapsed from exceeding the normal tolerance until the frequency recovers and remains within the frequency tolerance limits.

3.22 Safety Voltage

A voltage which does not exceed 35 V at rms (*see* Note 1) between conductors, or between any conductor and earth, in a circuit which is isolated from the supply mains by means such as a safety isolating transformer or converter with separate windings. A voltage which does not exceed 35 V dc between conductors or between any conductor and earth in a circuit which is isolated from the supply means.

NOTES

1 Limitation to voltages lower than 35 V ac rms may be specified in the particular standards especially when direct contact with live parts is involved.

2 The voltage limit should not be exceeded either at full load or no-load but it is assumed for the purpose of this definition that any transformer or convertor is operated at its rated supply voltage.

3.23 Materials

3.23.1 *Arc Resistant Material*

A material is said to be arc resistant when it is not excessively damaged by the action of the repeated arcs that may occur at its surface under actual duty conditions.

3.23.2 *Flame Retardant Material*

A material is said to be flame retardant when it does not transmit flame and does not continue burning longer than specified during the test defined in **33.2**.

3.23.3 *Incombustible Material*

A material which neither burns nor gives off flammable vapour or gas in a quantity sufficient to cause ignitions by a pilot flame when heated to a temperature in the neighbourhood of 750°C. Under the conditions defined in **33.1**.

Any material that does not fulfill this condition is deemed to be combustible.

3.23.4 *Moisture-Resistant Insulating Material*

An insulating material is considered to be "moisture-resistant" if insulation resistance of a specimen representative of the material as used does not fail below a specified value as a result of immersion in water when tested as defined in **33.3**. In case special precautions in the form of local protection for example by varnishing are normally employed the test should be made on specimens of the material protected in the same manner.

3.24 Spaces

3.24.1 *Accommodation Spaces*

Space used for public spaces, corridors, lavatories, cabinet offices, crew quarters, barber shops, isolated pantries and lockers, and similar spaces.

3.24.2 *Cargo Spaces*

Spaces used for cargo (including liquid cargo tanks) and trunks to such spaces.

3.24.3 *Dangerous Spaces*

Spaces where inflammable or explosive vapour, gas or dust, or explosives may be normally expected to accumulate.

3.24.4 *Machinery Space*

All spaces containing propelling machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations refrigerating, stabilizing, ventilation and air conditioning machinery, and similar spaces steering gear components and trunks to such space.

3.24.5 *Public Spaces*

Portions of the accommodation which are used by public (members of crew, passengers, etc), such as halls, dining-rooms, lounges, and similar permanently enclosed spaces.

3.24.6 *Service spaces*

Spaces which provide services to the crew and passengers, such as galleys, main pantries, stores (except isolated pantries and lockers), mail and specie rooms, laundry, workshops other than those forming part of machinery spaces and similar spaces and trunks to such spaces.

3.24.7 *Main Vertical Zone*

Sections into which the hull, superstructure and deck houses are divided by fire resisting bulkheads and decks. The mean length of these on any deck does not in general exceed 40 m.

3.24.8 *Machinery Control Room*

Spaces where machinery for control of propulsion/generators/cargo movement control, etc, is located.

3.25 Degrees of Protection of Enclosures

3.25.1 The enclosures referred to in the various parts of this standard are those as defined in the relevant Indian Standards relating to the classification of degree of protection provided by enclosures. The designation to indicate the degrees of protection consists of the characteristic letters IP followed by two numerals (the "characteristic numerals") indicating conformity with the conditions stated in Table 1 and 2.

Table 1 Degrees of Protection Indicated by the First Characteristic Numeral
(*Clause* 3.25.1)

First Characteristic Numeral	Degree of Protection	
	Short Description	Definitions
0	Non-protected	No special protection
1	Protected against solid objects greater than 50 mm	A large surface of the body, such as a hand (but no protection against deliberate access). Solid objects exceeding 50 mm in diameter
2	Protected against solid objects greater than 12 mm	Fingers or similar objects not exceeding 80 mm in length. Solid objects exceeding 12 mm in diameter
3	Protected against solid objects greater than 2.5 mm	Tools, wires, etc, of diameter or thickness greater than 2.5 mm. Solid objects exceeding 2.5 mm in diameter
4	Protected against solid object greater than 1 mm	Wires or strips of thickness greater than 1 mm in diameter
5	Dust-protected	Ingress of dust is not totally prevented but dust does not enter in sufficient quantity to interfere with satisfactory operation of the equipment
6	Dust-right	No ingress of dust

4 WORKMANSHIP AND MATERIAL

4.1 Good workmanship and adequate material are essential requirements for compliance with these standards.

5 APPLICABILITY OF THE STANDARDS TO AC AND DC

5.1 Except where a specific statement is made to the contrary, all standards are equally applicable in ac and dc installation, up to and including 1 000 V.

6 ACCEPTANCE OF SUBSTITUTES OR ALTERNATIVES

6.1 Where in these standards any special type of apparatus, construction or arrangement is specified, the use of any other apparatus, construction or arrangement is admissible, provided it is not less effective and reliable.

Table 2 Degrees of Protection Indicated by the Second Characteristic Numeral
(*Clause* 3.25.1)

Second Characteristic Numeral	Degree of Protection	
	Short Description	Definitions
0	Non-protected	No special protection
1	Protected against dry dripping water	Dripping water (vertically falling drops) shall have no harmful effect.
2	Protected against dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at any angle up 15' from its normal position
3	Protected against spraying water	Water failing as a spray at an angle up to 60° from the vertical shall have no harmful effect
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effect
5	Protected against water jets	Water protected by a nozzle against the enclosure from any direction shall have no harmful effect
6	Protected against heavy seas	Water from heavy seas or water projected with powerful jets shall not enter the enclosure in harmful qantities
7	Protected against the effect of immersions	Ingress of eater in a harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time
8	Protected against submersion	The equipment is suitable for continuous submersion in water under conditions which shall be specified by the manufacturer NOTE — Normally this will mean that the equipment is hermetically sealed. However with certain types of equipment it can mean that water can enter but only in such a manner that it produces no harmful effects

7 PROVISION OF MAXIMUM LOAD

7.1 All conductors, switchgear and accessories shall be of such size as to be capable of carrying, without their respective ratings being exceeded, the

current which can normally flow through them. They shall be capable of carrying anticipated overloads and transient currents, for example, the starting currents of motors, without injury or reaching undue temperature.

8 ADDITIONS AND ALTERATIONS

8.1 An addition or alteration, temporary or permanent, shall not be made to an existing installation until it has been definitely ascertained that the ratings and the condition of the existing accessories, conductors, switchgear, etc, affected are adequate for the new situation.

Special attention is drawn to factors affecting the existing system design such as current-carrying capacity, short-circuit level, voltage drop and proper discrimination of the protective device.

9 AMBIENT AIR AND COOLING WATER TEMPERATURES

9.0 Unless stated otherwise for the purpose of these standards, the following temperatures are assumed.

9.1 For all occean-going ship a temperature of ambient air or cooling water as follows:

a) a primary cooling water supply 0 to 30°C ;
b) an ambient air temperature 45°C for all equipment except machines located in machinery spaces, and for all equipment located in galleys, or on weather decks ;
c) an ambient air temperature of 50°C for machines located in machinery spaces ; and
d) an ambient air temperature of 40°C for equipment located in all other spaces.

9.2 For vessels such as coasters, ferries and harbour craft, all intended solely for use in northern or southern waters outside the tropical belt ; an ambient air temperature of 40°C and a temperature of primary cooling water supply of 25°C.

9.3 Where adverse and unusual ambients are expected to exist, special consideration should be given.

NOTE — In the above clause, the term "ambient air" refers to the air responsible for dissipating the heat losses from the equipment or cables concerned. This ambient air may be in the case of a ventilated machine the air drawn in via the cooling vent of in the case of cables the comparatively still air surrounding the cables.

9.4 For equipment for control and instrumentation, the ambient temperature conditions have been specified in IS 10242 (Part 5)/Sec 4.

10 INCLINATION OF SHIP

10.1 All electrical equipment shall operate satisfactorily under all conditions with the ship at the following inclinations from the normal:

Permanent life	− 15 °
Rolling	± 22.5 °
Trim	− 5 °
Pitch	± 10 °

Emergency installation shall in addition operate satisfactorily when the ship is inclined 22.5° and/or when the trim of the ship is 10°.

11 MATERIALS

11.1 Material and Finish

Material and finish of equipment shall be such that they withstand marine atmosphere under which they have to operate.

11.1.1 In general all electrical equipment shall be constructed of durable, flame-retardant, moisture-resistant materials which are not subject in deterioration in the atmosphere and the temperature to which, they are likely to be exposed.

12 POWER SUPPLY SYSTEM CHARACTERISITICS

12.1 General

Unless otherwise stated in other parts equipment shall function when supplied from general distribution systems with due regard to voltage and frequency variations harmonic distortion and conducted disturbances. The characteristics of general distribution systems are given in the following subclause.

NOTES

1 Where the power supply is obtained from the shore due regard should be paid to the effect that the quality of the supply if different from that specified in this clause may have on the performance of equipment.

2 For systems where semiconductors are connected having a total system rating, which is a significant portion of the total system rating, it may be feasible to suppress the harmonics. Consideration should be given to take appropriate measures to attenuate these effects of the distribution system so that safe operation is assured. Care should be taken in selecting consumers supplied from an electric supply system with a higher harmonic content that specified in this clause.

3 Electrical equipment which requires a higher quality power supply may need additional provisions to be made locally. Where additional equipment is fitted to achieve this higher quality power supply it may be required to the duplicated and segregated to the same degree as the electrical equipment it supplies.

4 Special attention should be paid to the installation of electrical equipment which may influence the quality of power supply on local basis or react with any harmonics present on the general distribution system.

5 Variable frequency/voltage systems may be admissible provided safe operation of the system is assured and that equipment is suitably rated for the expected variations.

12.2 AC Distribution Systems

12.2.1 *Voltage Characteristics*

Tolerances are expressed in a percentage of the nominal voltage. Voltage are root mean square (r.m.s) unless otherwise stated.

Voltage tolerance (continuous)..... + 6% – 10%

Voltage unbalance tolerance including phase voltage unbalance as a result of unbalance of load.....7%

Phase to phase voltage unbalance (continuous) 3%

Voltage cyclic variation deviation (continuous) 2%

Voltage transients :

transients (slow) e.g. due to load variations tolerance (deviation from nominal voltage).....+ 20% – 20%

Voltage transients recovery time... maximum 1.5 s.

NOTE — The sum of voltage excursions at any point on the system (tolerances and transient) from nominal voltage should not exceed 20%.

fast transients e.g. spikes - caused by switching peak impluse.

Voltage amplitude .....5.5 μnom

Rise time/delay time.....1.2 μs/50 μs

12.2.2 *Harmonic distortion (Voltage Waveform)*

Total harmonic distortion ..... not to exceed 5%

Single harmonic ..... not to exceed 3%

12.2.3 *Frequency Characteristics*

Tolerances area expressed in a percentage of the nominal frequency.

Frequency tolerance (continuous)..... + 5% – 5%

Frequency cyclic variation tolerance (continuous) 0.5%

Frequency transients tolerance..... + 10% – 10%

Frequency transients recover time..... maximum 5s

NOTE — The sum of frequency excusions at any point on the system (tolerances and transient) from nominal frequency should not exceed 12.5%.

12.3 D.C. Distribution System

Tolerances are expressed in a percentage of the nominal voltage.

Voltage tolerance (continuous)..... + 10% – 10%

Voltage cyclic variation deviation 5%

Voltage ripple (a.c. r.m.s. over steady d.c. voltage) 10%

NOTE — When battery chargers/battery combinations are used a d.c. power supply systems adequate measure should be taken to keep the voltage within the specified limits during charging, quick charging and discharging of the battery.

Fast transients for example spikes caused by switching peak impulse voltage amplitude

24 V d.c. systems.....500 V

110 V d.c. systems.....1500 V

220 V d.c. systems.....2 500 V

Rise time/delay time .....1.2 μs/50 μs

13 ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES

When an apparatus is required to be suitable for explosive gas atmospheres, it shall be type tested by a recognized competent independent testing authority in accordance with the relevant Indian Standards.

14 PRECAUTIONS NECESSARY WHEN ELECTRICAL FITTINGS CABLES, ETC, ARE ATTACHED TO ALUMINIUM STRUCTURES

14.1 If electrical fittings, not of aluminium, are attached to aluminium, suitable means shall be provided to prevent electrolytic corrosion.

15 CLEARANCE AND CREEPAGE DISTANCES

15.1 The distance between live parts of different potential and between live parts and the case of other earthed metal, whether across surfaces or in air, shall be adequate for the working voltage, having regard to the nature of the insulating material and the conditions of service.

16 INSULATION

16.1 Insluating materials and insulated windings shall be resistent to moisture, sea-air and oil vapour unless special precautions are taken to protect insultants against such agencies.

NOTE — As a consequence of this clause, insulating materials in important applications, such as a busbar supports, etc should have sufficient resistance against tracking. It is recommended that the comparative tracking index of such materials is not less than 175 V when determined according to IS 2824 : 1975.

17 MAINTENANCE AND INSPECTION

17.1 Equipment shall be so designed and installed as to permit its being maintained and inspected as required for all its parts.

18 PILOT LAMPS

18.1 Pilot lamps shall, as far as practicable, be capable of replacement without the use of tools.

19 CABLE ENTRIES AND TERMINATIONS

19.1 Cable glands or bushings, or fittings for screwed conduit, shall be provided according to the way in which the cables enter the apparatus. Enclosures of apparatus with a degree of protection of IP X 2 should not have cable entries on the top, unless the cable entry plate and/or cable attachment is so made as to exclude water entry.

19.1.1 *Terminals*

Suitable terminals shall be fitted to the equipment. These terminals shall be clearly marked as per the relevant Indian Standard and placed in an accessible and enclosed position convenient for external connections. These terminals are to be effectively secured and shall be so spaced/shrounded that they cannot be inadvertently earthed/short circuited. Adequate clearance shall be allowed between the cable entries and the terminals so that the cables can be drawn in and connected up without damage.

20 PRECAUTIONS AGAINST VIBRATION AND MECHANICAL SHOCK

20.1 Machines and apparatus shall be unaffected by vibrations and shock likely to arise under normal service. Screws and nuts securing current-carrying parts shall be effectively locked, so that they cannot work loose by vibration. The locking of screws and nut securing not current-carrying parts is recommended where a necessary.

Electrical equipment shall be constructed to withstand at least the following:

Vibration frequency range : 5 - 50 Hz with vibration velocity amplitude 20 mm/s.

Peak accelerations caused by the vessel's movements waves $\pm$ 6 m/s^2 (g = + 0.6) for vessels of length exceeding 90 m, and $\pm$ 10 m/s^2 (g = + 1) for smaller vessels, with duration 5 - 10 s.

NOTE — The specified vibration levels are considered as (average adverse conditions) for power, lighting and heating equipment.

Larger vibrations may occur in some cases (for example, for flexible mounted diesel generator sets), and special consideration is then to be given to the construction of the equipment.

21 POSITION IN SHIPS

21.1 Compartments in which electrical apparatus is plated shall be suitably constructed and if necessary ventilated.

21.2 Electrical apparatus shall not be installed where flammable gases or vapours are liable to accumulate, except where the installation of apparatus for explosive gas atmospheres is provided for in this standard.

22 COMPARTMENTS

22.1 Compartments in which engine-driven generating sets are plated shall be constructed of metal or other incombustible material. Compartments or cupboards containing switchgear assemblies shall be constructed of or lined with incombustible material.

23 MECHANICAL PROTECTION

23.1 Electrical equipment shall be so placed that as far as practicable it is not exposed to risk of mechanical injury.

24 PROTECTION FROM WATER, STEAM AND OIL

24.1 Electrical equipment shall be so selected and located that it is unaffected by any water, salt spray and saline deposits, steam oil and oil fumes to which it is likely to be exposed.

25 PROTECTION FROM DRIP

25.1 Where necessary, electrical equipment with a degree of protection less than IP X 2 shall be provided with a canopy or other suitable means to protect the current-carrying parts and their insulation from drip.

26 PROTECTION AGAINST ELECTRICAL SHOCK

26.1 All electrical equipment shall be constructed or located in such a way that live parts cannot be inadvertently touched, unless supplied at a safety voltage according to **3.18**.

26.2 Equipment supplied at nominal voltages in excess of 500 V ac and accessible to non-authorized persons shall have a degree of protection against touching live parts of at least IP 4 X.

27 AXES OF ROTATION

27.1 Every horizontal rotating machine shall preferably be installed with the shaft in the fore - and-aft direction. Where a machine is installed athwartship, it shall be ensured that the design of the bearings and the arrangements for lubrication are satisfactory to withstand the rolling specified in **10**, the manufacturer shall be informed when a machine for installation athwartship is ordered.

28 SPACE FOR MAINTENANCE

28.1 Electrical apparatus shall be so installated that sufficient space is available for maintenance.

29 ADJACENT COMBUSTIBLE MATERIAL

29.1 Electrical equipment with a degree of protection IPOO shall not be plated within 30 cm measured horizontally, or 120 cm measured ver-

tically, from any unprotected woodwork or readily combusible material.

30 HANDRAILS

30.1 Machine, switchboards or controlgear assemblies with a degree of protection of IPOO shall be provided with handrails where these are necessary to obviate risk of injury to persons.

31 MAGNETIC COMPASSES

31.1 Condutors and equipment shall be placed at such a distance from the compass shall be so screened that the interfering external magnetic field is negligible (deviation less than 0.5) even when circuits are switched on and off.

32 ENCLOSURES

32.1 Enclosures shall comply with the degrees of protection defined in **3.21** of this standard. Enclosing cases for electrical equipment shall be of adequate mechanical strength and rigidity and so mounted that their closing arrangements and the functioning of the built-in equipment will not be affected by distortions, vibrations and movements of the ships construction or by other injuries likely to occur.

33 CLASSIFICATION TEST FOR MATERIALS

NOTE — The does not apply to electric cables for which a special test is under consideration.

33.1 Incombustibility Test

33.1.1 *Principle of Test*

The sample shall be introduced into a chamber which has been preheated to 750°C and the reaction of the material in the presence of heat judged according to whether it burns or not, or according to the behaviour of the pilot flame positioned above the distillation chamber

33.1.2 *Description of Test Equipment*

The distillation chamber shall in principle be of cylindrical shape, with a diameter of 76 mm and a height of 250 mm. The upper part shall be heated over a height of at least 125 mm by an electrical resistance, through an insulating refractory wall (heating tube). Nine holes, 3 mm in diameter, shall be drilled through the bottom of the test chamber. The cover shall be arranged to have a central slot of adjustable width between 6 mm and 8 mm over the whole decimator of the cylindrical distillation chamber.

The temperature shall be read by means of a thermocouple placed in the centre of the distillation chamber, halfway between the sample under test and the inner face of the chamber. The sample shall be suspended at the centre of the heating tube throughout the duration of the test.

33.1.3 *Preparation of Test Samples*

The sample shall have an overall volume between 4 and 6 cm^3. Standard size : 50 × 20 mm approximately. If the material is less than 3 mm thick the requisite volume should be constituted by making up pieces size 50 × 25 mm into a packet held fast with a copper wire.

33.1.4 *Test Procedure*

The distillation chamber shall be preheated to 750°C and the sample quickly inserted in the chamber. The duration of the test is 10 min.

33.1.5 *Results of Test*

The material tested is deemed not to be incombustible :

a) if the material burns spontaneously inside the distillation chamber ; and

b) if the pilot flame, the initial height of which shall be 10±2 mm reaches a height of 30 mm with a characteristic alteration in colouring. A mere change in the colour of the flame unaccompained by any marked increase in height, is not deemed to be indicative that the material is combustible.

33.2 Tests for Flame Retardent Material

33.2.1 *Procedure.*

The test shall be carried out at normal ambient temperature and away from draughts. The test specimen consists of a bar or strip of length at least 120 mm 10 mm wide and 3 mm thick. Test specimens of other sizes may also be accepted. An increase in length beyond 120 mm is unimportant. In the case of tubes or sections the straight section of which is not notably larger than a rectangle of 10 × 3 mm in size and area the test may be carried out on a 120 mm length of the object. The thickness of the sample can be 10 mm without disadvantage. The test specimen shall be fastened to a thin metal wire so that its longitudinal axis is inclined at an angle approximately 45° to the horizontal and its transverse axis is horizontal.

A Bunsen burner when adjusted in still air and in the vertical position is approximately 125 mm long, the blue part of the flame being about 35 mm long. The burner axis shall be set vertically in such a position that the tip of the blue part of the flame just touches the lower end of the specimen. The flame shall be applied 5 times for 15 s at a time with an interval of 15 s between each application.

After the last application the specimen shall be allowed to burn itself out. The material is deemed

to be flame retardant if the burnt and damaged part of the specimen is not more than 60 mm long.

33.3 Test for Moisture Resistance

33.3.1 *Methods of Measurement Insulation Resistance*

The insulation resistance shall be determined by appropriate methods given in IS 2259 : 1963 modified as follows and as given in **33.2.3** below. The dimensions of the test specimens shall be as follows :

Type of Electrodes	*Form of Material*	*Size of Test Specimen*
Taper Pin	Plates	50 × 75 mm
Taper Pin	Tubes and Rods	75 mm long
Conducting paint	Plates	60 × 150 mm
Conducting paint	Tubes and Rods	60 mm long
Bar	Plates	25 mm wide

33.3.2 *Procedure*

a) *Preparation of specimens* — Electrodes shall be affixed or applied to the test specimen before the operations (b) and (c).

Where special precautions against absorption for example, coating with varnishes are normally applied to the materials in practice, the test specimen shall be treated in the same manner before affixing or applying the electrodes and before proceeding with (b) and (c).

b) *Preconditioning* — The specimen shall be dried in a ventilated oven at a temperature of 50 ± 2°C with a relative humidity less than 20 percent for 24 h and shall be cooled to the ambient temperature (15 to 20°C).

c) *Water immersion* — The specimen shall be immersed in distilled water at a temperature of 23 ± 0.5°C for 24 hours within one hour after preconditioning and cooling as in (b).

d) *Insulation resistance measurement after immersion in water* — The specimen shall be removed from the water after immersion as in (c) and surplus water removed from the surface by pressing with a clean dry cloth or filter paper. The insulation resistance shall then be measured as quickly as possible. The time between the removal of the specimen from the water and commencement of the measurement shall not exceed 2 min. The insulation resistance shall be measured after the specimen has been electrified for 1 min.

NOTE — Appropriate values for the minimum insulation resistance are being investigated and are in abevance for the present.

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This Indian Standard has been developed from Doc: No. ETD 26 (3585).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Simco Printing Press, Delhi, India